Tank Barge DBL 152 Incident Response

Environmental Unit Report

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Prepared by

ENTRIX

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Prepared for

Tank Barge DBL 152 Incident Response Environmental Unit Report

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Table of Contents

Appendices

Tables

Figures

Abbreviations & Acronyms

API	American Petroleum Institute
FOSC	Federal On-Scene Coordinator
GNOME	General NOAA Operating Model Environment
ICS	Incident Command System
LTM	Long Term Monitoring
NDBC	National Data Buoy Center
nm	Nautical Mile
NOAA	National Oceanic and Atmospheric Administration
NRDA	Natural Resource Damage Assessment
NRDAM/CME	Natural Resource Damage Assessment Model for Coastal and Marine Environments
OSPR	Oil Spill Prevention and Response
PADR	Pre-Assessment Data Report
PAH	Polycyclic Aromatic Hydrocarbons
ROV	Remotely Operated Vehicle
RP	Responsible Party
RPI	Research Planning, Inc.
SSC	Scientific Support Coordinator
TABS	Texas Automated Buoy System
T/B	Tank Barge
TGLO	Texas General Land Office
USCG	United States Coast Guard
V-SORS	Vessel-Submerged Oil Recovery System
VSS	Vertical Snare Sampler

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SECTION 1

Introduction

This report summarizes activities performed by the Environmental Unit during the Tank Barge (T/B) DBL 152 Incident that occurred in federal waters of the Gulf of Mexico beginning on November 11, 2005. This document was prepared on behalf of the Environmental Unit for the United States Coast Guard (USCG), Marine Safety Unit Port Arthur, Texas, by ENTRIX, Inc. (ENTRIX). ENTRIX is the environmental consultant retained by the Responsible Party (RP) for this incident. K-Sea Transportation Partners LP, the owner/operator of the vessel which discharged oil, is the RP for this incident.

The Environmental Unit was comprised of representatives from the USCG, National Oceanic and Atmospheric Administration (NOAA) (and their contractor, Research Planning, Inc.)(RPI), Texas General Land Office (TGLO) and ENTRIX. The purpose of this report is to summarize and document the offshore activities conducted by the Environmental Unit, as well as the decision-making processes that were utilized to direct those activities. Results from all the efforts conducted during the emergency response and long-term monitoring phases of the DBL 152 Incident are also provided. The Environmental Unit report is organized as follows:

- Section 2 contains a brief overview of the incident;
- Activities conducted during the Initial Response Phase are summarized in Section 3;
- The Long-Term Monitoring (LTM) plans and results are provided in Section 4;
- Section 5 summarizes contingency plans for potential impacts to shoreline resources;
- Section 6 summarizes results of the oil budget/mass balance; and
- References are provided in Section 7.

Photos collected during the emergency response and long-term monitoring efforts are located on a DVD which is included with this report.

The Environmental Unit also cooperated in providing logistical support as part of the Natural Resource Damage Assessment (NRDA) process for the DBL 152 Incident. The results of these efforts are provided in the Pre-Assessment Data Report (PADR) (ENTRIX and NOAA, 2008).

This report does not document any of the activities conducted at Theodore Industrial Port in Mobile Bay, Alabama, where the T/B DBL 152 was hauled for final cleaning and salvage. A separate report dated April 27, 2007 documenting these activities was prepared by ENTRIX and provided to the USCG Sector Mobile Incident Management Division.

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SECTION 2

Incident Summary

On November 11, 2005, while enroute from Houston, Texas to Tampa, Florida, the integrated tug-barge Rebel and T/B DBL 152, owned and operated by K-Sea Transportation Partners LP, the RP, allided[1] with the submerged remains of a pipeline service platform located in the northwest Gulf of Mexico (West Cameron Block 229) that collapsed during Hurricane Rita. The double-hulled barge was carrying approximately 119,793 barrels (5,031,317 gallons) of a blended mixture of low-API (American Petroleum Institute) gravity (4.5) slurry oil. The starboard bow cargo and ballast tanks were holed, at which time the barge began taking on water and releasing oil. A relatively minor amount of the released oil floated forming an oil slick on the surface of the water. However, it was later determined that the majority of the oil sank to the seafloor as a result of having a specific gravity greater than that of seawater.

At the time of the allision, the crew was unaware that the vessel had struck a submerged object. Only later, when the tug and barge unit began listing, were they alerted of a problem. At that time, the tug and barge were separated for safety reasons, but remained together in close proximity. The barge was eventually reconnected and towed inland with the intent of grounding it in shallower water to facilitate lightering and salvage and to minimize the risk of striking buried oil pipelines on the seafloor. The barge grounded farther from shore than anticipated in 50 to 60 feet of water approximately 13 nautical miles[2] (nm) northwest of the allision site or approximately 35 nm south-southeast of Sabine Pass, Texas and Calcasieu Pass, Louisiana (Figure 2-1). Once grounded, the barge continued listing severely and slowly releasing smaller amounts of oil from unsealed vents and hatches. On November 14, 2005, the barge capsized and additional oil was released in a relatively short period of time and was deposited on the seafloor as large, discrete mats or pools of submerged oil.

It was later discovered that a leg from the platform remained lodged in the vessel's hull following the allision and was dragged across the seafloor for a period of time forming a scour trench approximately 3.5 nm long. At the time it was discovered, the 4-6 foot wide and 10-12 inch deep trench was filled with oil to a depth of 2-6 inches. The oil is believed to have "wicked" down the platform leg and into the trench as the barge continued moving.

Extensive operations to locate, assess and recover the submerged oil were initiated shortly after the barge capsized. Full-scale submerged oil recovery efforts using diver-directed pumping were initiated by early December 2005. Submerged oil cleanup activities were conducted subject to intermittent weather delays until January 12, 2006, at which time recovery operations were suspended by the Unified Command. Long-term monitoring of non-recovered submerged oil was initiated in January 2006 and continued for a period of approximately one year. Based on the results of long-term monitoring and on-going feasibility constraints, no additional submerged oil recovery was performed after January 2006.

An estimated 45,846 barrels (barrels) of oil (1,925,532 gallons) were discharged into federal waters of the Gulf of Mexico as a result of this incident. Of this volume, an estimated 2,355 barrels (98,910 gallons) were recovered by divers. In total, 43,491 barrels (1,826,622 gallons) of unrecovered oil was left remaining in the environment. Additional details regarding the mass balance calculations are presented in Section 6.0.

[1] The term "allision" refers to the action of a moving object hitting against a fixed object, whereas "collision" is used when both objects are moving.
[2] One nautical mile equals 6,076 feet.

Figure 2-1 Location of T/B DBL 152 Incident

S E C T I O N 3

Initial Response Phase

3.1 ENVIRONMENTAL UNIT RESPONSIBILITIES

The emergency response effort was organized and functioned in accordance with the Incident Command System (ICS). An Environmental Unit was established within the Planning Section. The Environmental Unit was comprised of representatives from the USCG, NOAA (and their contractor, RPI), TGLO and ENTRIX (K-Sea's environmental consultant).

- Major Environmental Unit responsibilities included:
- Providing scientific support to the Federal On-Scene Coordinator (FOSC) and other Unified Command members through the NOAA Scientific Support Coordinator (SSC);
- Sampling oil and affected/potentially affected media;
- Preparing trajectory analyses;
- Obtaining accurate weather forecasts;
- Detecting and tracking the movement of submerged oil;
- Determining resources at risk;
- Assessing shoreline impacts;
- Developing cleanup endpoints;
- Evaluating environmental trade-offs of response alternatives;
- Tracking waste disposal; and
- Coordinating with NRDA trustees and RP representatives.

Environmental Unit membership was variable throughout the response based on task assignments and personnel rotations. Members of the Environmental Unit worked in close coordination with the Unified Command and general staff within other ICS sections, most notably the Operations Section and Logistics Section.

3.2 RESOURCES AT RISK

Resources at risk from released oil were identified shortly after the spill occurred and periodically reevaluated throughout response operations. On November 13, 2005, NOAA and RPI provided information pertaining to potential resources at risk, including biological resources, shoreline resources, and human-use resources. Given that the released oil was heavy slurry oil with a specific gravity greater than seawater, the presence of submerged oil was identified as the greatest risk to benthic resources. Floating oil posed a lesser risk to resources given the smaller quantity released and its expected rapid dispersion. Biological resources potentially at risk included benthic fish, benthic invertebrates, and marine reptiles (e.g., Loggerhead and Kemp's Ridley sea turtles). The potential risks to these biological resources included coating with oil, smothering, and/or ingestion of oil while feeding. Pelagic birds and marine mammals were not likely to be at risk of impact from the bulk slurry oil. Human-use resources potentially at risk included commercial shrimp fishing. The Padre Island National Seashore was identified as a potential resource at risk. However, no shorelines were identified to be at risk from impact. The Flower Garden Banks National Marine Sanctuary is located approximately 70 nm south of the spill site. The Environmental Unit evaluated potential risks to this resource and determined that given the location relative to the spill site and underwater current patterns, the sanctuary was not likely to be at risk from impact.

3.3 FATE AND BEHAVIOR OF SUBMERGED OIL

3.3.1 Oil Character and Chemistry

The product discharged from the T/B DBL 152 is characterized as slurry oil, a type of residual oil comprised of a complex and highly variable combination of hydrocarbons predominantly greater than C-20, as well as 4- to 6-ring aromatic hydrocarbons and hydrogen sulfide. Slurry oil is the heavy, residual fraction of catalytic cracking, a refining process used to produce high-quality gasoline components from heavier crude oil distillation fractions such as heavy gas oil and lubricating oil. Slurry oil is often clarified by filtration to reduce its solids content, which is derived from the catalyst. It is frequently necessary to dilute slurry oil with No. 6 oil to make it marketable as industrial boiler fuel, which was the intended use of the slurry oil aboard the T/B DBL 152.

The slurry oil loaded aboard the T/B DBL 152 at Houston Fuel Oil Terminal was a mixture of five (5) different oils each originating from a different shore tank. The API gravity[3] and approximate volume of each product loaded aboard the T/B DBL 152 is summarized in Table 3-1.

Table 3-1 Oil Cargo aboard the T/B DBL 152

API (@60°F)	9.7°	3.8°	-2.3°	3.9°	24.6°
Barrels	10,300	50,700	15,500	41,950	1,870

According to Intertek Caleb Brett, a consultant to K-Sea, the barge was loaded using a procedure known as “line blending” where the flow and volume of oil from each shore tank is regulated to meet the target API gravity of the mixture (J. Dwyer, pers. comm., 2006). The line blend mixture was spread evenly into the barge tanks. As a last step, an additional quantity of 9.7° API gravity oil was loaded to the bottom of each tank to promote mixing, which occurs through buoyancy forces and the rocking motion of the vessel during the voyage (J. Michel, pers. comm. 2005).

Intertek Caleb Brett created an ideal blend of the oil mixture in the laboratory based on the actual volumes of oil loaded onto the barge. The API gravity of the ideal blend was reported as 3.8° (at 60°F). The API gravity of a composite sample collected from the actual blend in the barge was 4.5° (at 60°F). Intertek Caleb Brett measured the viscosity of the composite sample to be 54.4 sfs (or 110 cSt) at 122° Fahrenheit.

Louisiana State University analyzed two (2) samples of oil from the barge on behalf of NOAA HAZMAT to determine its fingerprint characteristics and physical properties. Results from the fingerprinting analysis indicated the oil originated from a heavy crude oil with normal alkanes ranging from C-10 to C-34. The oil contained high concentrations of asphaltenes and other unresolved high molecular weight compounds. It also

[3] American Petroleum Institute gravity, or API gravity, is a measure of the relative density of a petroleum liquid compared to water. Oils with API gravity greater than 10° will float in freshwater at 60°F, while oils with API gravity less than 10° will sink. Oils with API gravity less than approximately 6.5° at 60ºF will sink in seawater (35 ppt) (National Research Council, 1999).

contained high concentrations of aromatic compounds, suggesting it may have been blended with diesel or light oil. Physical properties that were analyzed included density and viscosity, which were measured at a range of temperatures to obtain information about the behavior of the spilled oil under variable conditions. Results from analyses of physical properties are summarized in Table 3-2. The complete laboratory report is provided in Appendix A.

Table 3-2 Results of Density and Viscosity Analyses

	DBL 152 Sample Tank 1-S		DBL 152 Sample Tank All	
Temperature	Density (g/mL)	Viscosity (cSt)	Density (g/mL)	Viscosity (cSt)
22°F	1.0203	n/a	1.0247	n/a
50°F	1.0248	n/a	1.0401	~10,000
72°F	1.0215	1,908	1.0276	1,511
117°F	1.0142	162	1.0150	136

3.3.2 Trajectory Analysis

The Environmental Unit was responsible for providing trajectory analyses to predict the movement and location of spilled oil. This function was provided primarily by NOAA HAZMAT via the NOAA SSC. Trajectories were prepared using the General NOAA Operating Model Environment (GNOME) oil spill trajectory model and were typically, but not always, updated twice daily (0800 hrs and 1600 hrs.). Initial spill trajectories focused on floating oil that initially formed a surface slick extending up to 12 miles from the vessel. Once it was understood that most of the released oil sank to the seafloor, both surface and mid-depth spill trajectories were prepared. NOAA trajectories span the time period from November 11, 2005, immediately following the incident, to November 23, 2005.

Following capsize of the barge, the Environmental Unit was asked by the Captain of the Port to provide worst-case discharge (catastrophic release of all remaining oil onboard) trajectories for both floating oil and submerged oil. Trajectories for these scenarios were prepared by ENTRIX using NOAA’s Natural Resource Damage Assessment Model for Coastal and Marine Environments (NRDAM/CME). Neither the GNOME or NRDAM/CME models were specifically designed or intended to model the movement of submerged oil on the seafloor. As a result, model outputs predicting the movement of submerged oil contained a high degree of uncertainty. Worst-case trajectories were prepared for a two-day period (November 15-16, 2005), but were discontinued once the threat of a catastrophic discharge lessened and the inability to accurately predict movement of submerged oil on the seafloor was recognized. Appendix B contains all of the various types of spill trajectories prepared by the Environmental Unit for this incident.

3.3.3 Conceptual Model of Submerged Oil Movement

The NOAA Scientific Support Team and other members of the Environmental Unit developed a conceptual model for the movement of submerged oil as a first step in understanding and predicting the long-term fate and transport of the spilled material. These mechanisms were described in NOAA's technical paper entitled "Long-Term Transport of Oil from T/B DBL 152" as well as various presentations to the Unified Command and Regional Response Team (Appendix C). Important concepts presented in this paper for understanding the movement of oil are summarized below.

- Current velocity in the vicinity of the barge decreases with depth and is very low close to the seafloor. This relationship is confirmed by data from the acoustic doppler current profiler aboard the Texas Automated Buoy System (TABS) A2 Buoy deployed near the incident location.

- Average bottom currents in the vicinity of the barge are insufficient to break-up or move the oil contained in large, discrete mats.
- The viscosity of T/B DBL 152 oil is relatively low compared to other heavy oils. As a result, large oil mats are expected to break-up into multiple smaller pieces more easily than thicker, more viscous heavy oils. The tendency of the oil to break-up into smaller globules when disturbed has been confirmed by diver and Remotely Operated Vehicle (ROV) observations.
- Wave energy from smaller, short period waves that dominate during fair weather periods does not propagate to the bottom. Wave energy from larger, long period waves (>5 sec.) associated with storms and heavy weather does reach the bottom.
- Wave energy propagated to the bottom above a certain threshold can cause oil mats to break-up and can re-suspend smaller oil globules in the water column. Based on observational data from this incident, NOAA estimates that 6 m^2/Hz is a reasonable threshold for oil mobilization. Less energy may be needed to re-suspend smaller particles of oil.
- Horizontal transport of oil is primarily a function of currents, not wave energy. Once oil is re-suspended by wave energy propagating to the bottom, it is carried horizontally by subsurface currents.
- The distance oil is transported horizontally is a function of both subsurface current velocity and globule size, which determines how long globules will remain suspended. Larger globules will settle to the bottom more rapidly than smaller globules; therefore smaller globules will remain suspended long and be transported farther than larger globules.
- Oil particles smaller than 0.5 mm may remain in suspension indefinitely but could be affected by sedimentation or biodegradation.

NOAA's technical paper also examined the long-term transport mechanisms of the Louisiana-Texas continental shelf in order to help predict the long-term fate of spilled oil with respect to the likelihood of impacts to Gulf Coast shorelines and/or the Flower Garden Banks National Marine Sanctuary. Major conclusions are summarized below.

- Based on analysis of historic wave energy data from nearby buoys, NOAA predicts that bottom wave energy will exceed the threshold for oil mobilization described above many times in the year following the spill and beyond.
- Winter weather patterns especially are expected to cause a repeating pattern of periodic remobilization of oil that will continue to break-up larger oil mats into smaller pieces and distribute those smaller pieces over an increasingly wider area.
- Small globules of oil are not expected to reform into larger mats due to lack of convergence zones at the bottom or other mechanism(s) that could bring small oil globules together with enough force to coalesce.
- Long-term transport of submerged oil globules is expected to be downcoast (Louisiana to Texas) and offshore. This general trajectory is based on sediment transport studies from the Louisiana-Texas shelf area, which NOAA has determined are applicable based on similarities between the two materials relevant to subsurface transport.
- Based on an extensive current survey of the Louisiana-Texas shelf in the early 1990s (Louisiana-Texas Shelf Physical Oceanography Program study), there is a higher probability of oil moving offshore than onshore. Although waves generated during storms could be capable of remobilizing the oil, they will also continue to break the oil up into smaller and smaller pieces.

For reasons cited above, NOAA believes shoreline impacts from submerged oil from the T/B DBL 152 are highly unlikely. Even if currents were able to move oil into nearshore areas, these currents eventually turn parallel to the shoreline boundary, which would move oil along the coast, not up onto the beach.

The Flower Garden Banks National Marine Sanctuary is not expected to be within the long-term trajectory of this spill. These reefs extend to within 50-100 feet of the surface atop salt domes, with surrounding bottom depths of 300 feet or more. Circulation studies have shown that water at depth flows around structures like the Flower Garden Banks, rather than up and over top of them. So, even if the banks were in the long-term trajectory, oil would be moving around the base of the salt domes below the depth of the reefs.

The State of Texas, represented by TGLO, does not fully agree with NOAA's long-term fate and transport predictions. In several previous cases involving offshore spills of both floating and non-floating oil in the western Gulf of Mexico, Texas shorelines have been impacted by oil, usually in the form of tarballs or tar patties. Based on these past experiences, the TGLO believes that the central and south Texas coasts generally from Mustang Island/Corpus Christi to South Padre Island are at risk of being impacted by oil from this incident, though they do not speculate about the magnitude of such impact. TGLO acknowledges the large degree of uncertainty that exists in predicting the long-term fate and transport of submerged oil from this incident.

3.3.4 Meteorological and Oceanographic Data

Meteorological and oceanographic data reported by various sources were compiled during the response. Data sources included an ocean buoy deployed near the capsize location, as well as other buoys and National Data Buoy Center (NDBC) assets in the western Gulf of Mexico. Of key importance was the near-bottom and mid-water column current direction and velocity data provided by the Acoustic Doppler Current Profiler aboard the TABS A2 buoy, which was deployed near the barge (29º 12.13' N / 93º 29.98' W) from December 7, 2005 through March 5, 2006 by Texas A&M University specifically for this incident. Information on sea state (wave height, and dominant and average wave period) was obtained from NDBC Station 42035 located 22 nm east of Galveston, Texas and Station 42019 located 60 nm south of Freeport, Texas. These ancillary data were used to better understand and potentially predict the movement of submerged oil in response to various environmental factors.

3.4 SUBMERGED OIL DETECTION AND RECOVERY

During the initial response phase, locating submerged oil as quickly as possible and determining appropriate and effective recovery methods was a major goal of the Environmental Unit. The initial response period includes the interval from November 11, 2005 to January 12, 2006 during which time recovery of submerged oil was actively pursued, supported by various efforts to detect and assess submerged oil. Salvage and lightering operations to remove the remaining oil and secure the vessel in preparation for towing it to a shore facility were also performed during this period.

Throughout the initial response, information about the location, concentration and movement of submerged oil was critical in support of oil recovery operations and predicting the fate and transport of oil. Unlike spills of floating oil, where oil can be readily observed using familiar techniques (e.g., overflights, shoreline surveys), submerged oil detection and assessment is considerably more challenging, yet the need for this information still exists.

A wide variety of methods and equipment were employed to locate, characterize and track submerged oil during the initial response. These included commercial divers, chain-weighted snare drags using devices called V-SORS (Vessel-Submerged Oil Recovery System), ROV, and acoustic remote sensing. These efforts are summarized in the sections below.

3.4.1 Dive Surveys

Commercial divers were used to support numerous operational aspects of the response including, but not limited to salvage, lightering and submerged oil recovery. The Environmental Unit used divers to obtain source oil and certain water column samples, to verify/calibrate results of other submerged oil identification methods and to deploy submerged oil tracking gear.

Initial reconnaissance of submerged oil was provided by divers surveying the allision site, the various debris fields and the disabled barge shortly after the incident occurred. Conditions dictated the use of surface-supplied air; therefore, divers remained tethered to an anchored support vessel. Divers typically maintained voice communications with support personnel topside. Some dive surveys were video taped. Unrecorded dive observations were communicated via written dive reports or verbal debriefings.

Dive surveys were constrained by limited bottom-time (due to depth-related decompression requirements), restricted mobility, and at certain times, poor visibility. The inability to cover relatively large areas in short periods of time rendered dive surveys an ineffective means of detecting, assessing and monitoring the nature and extent of submerged oil for both operational and monitoring purposes. Once it was realized that the extent of submerged oil exceeded the capabilities of divers, alternative methods for surveying submerged oil were sought.

3.4.2 Chain-Weighted Snare Drags

Chain-weighted snare drags (chain drags) using V-SORS was one of the primary data collection methods used for gathering information about the nature and extent of submerged oil. The V-SORS concept was initially conceived as a method for submerged oil recovery for another spill; however, these devices proved most useful for that incident as a means of detecting, assessing and monitoring submerged oil over relatively large areas in relatively short time frames.

Two versions of the V-SORS device were used for the T/B DBL 152 incident. The original configuration, later called "V-SORS Heavy" consisted of an 8-foot wide header beam constructed of heavy steel pipe trailing 25 8-foot long heavy-link chains to which six to eight viscous snare pompoms were attached along the length of every other chain. Deployment and retrieval of the V-SORS Heavy device required a crane or other overhead mechanical lifting equipment aboard the survey vessel.

Due to operational constraints, a scaled-down version of the V-SORS known as "V-SORS Light" was developed. The V-SORS Light device consisted of two 8-foot lengths of heavy-link chain each carrying three snare pompoms. The V-SORS Light gear was attached to the end of a single rope and was light enough to be deployed and retrieved by hand. Often times, two units were simultaneously towed from opposite sides of the survey vessel.

Both V-SORS Heavy and V-SORS Light were towed across the seafloor along pre-designated transects navigated using a global positioning system. At specified intervals, the gear was hoisted to the surface to inspect the pompoms. The amount of oil on the pompoms was visually assessed and a qualitative level of oiling (heavy, medium, light & very light) was assigned to the segment. To the degree possible, crews performing V-SORS surveys were kept the same to ensure consistent classification of oiling levels on snare pompoms. Additionally, a pictorial job aid was created to help calibrate assignment of oiling levels across teams. V-SORS provided a spatially integrated assessment of submerged oil along a transect at a specific point in time (e.g., a "snapshot"). Survey resolution was dependent upon distance between adjacent transects and retrieval frequency (distance) along individual transects. Crews were able to survey relatively large areas in a short period (e.g., several hours) and results were available in near real-time (i.e., no data processing lag time).

Initial V-SORS surveys commenced on November 19, 2005 and were completed within approximately one week. These surveys focused separately on the barge site (Area A) and the scour trench (Area B). Maps depicting the results of these surveys are provided in Appendix D. Concern for damaging underwater pipeline infrastructure (e.g., protruding valves, etc.) delayed initiation of V-SORS surveys by a few days until pipeline owners could be contacted and field verification surveys completed, where necessary.

A second round of V-SORS surveys was initiated on December 1, 2005 and completed on December 16, 2005 after a nearly one week weather delay. These surveys focused primarily on the area west of the barge (Area A). The results of these surveys are also provided in Appendix D. V-SORS were not used for submerged oil detection and assessment in any significant manner after mid-December.

3.4.3 Acoustic Remote Sensing

Two types of acoustic remote sensing were used to detect submerged oil with varying degrees of success during the T/B DBL 152 response: RoxAnn Seabed Classification System and side scan sonar. RoxAnn was briefly tested for its ability to detect submerged oil in late-November 2005. Initial results were mixed due to equipment malfunctions and heavy seas. The use of RoxAnn equipment was discontinued after a short period based on the inconclusive results and the narrow assessment swath on the bottom, which was a function of the relatively shallow water depth (50-60 feet).

Side scan sonar was initially used on the incident to survey debris around the allision site and secondary debris field, but was later used experimentally for submerged oil detection. Initial trials to detect submerged oil with side scan sonar were promising. However, during a late-November 2005 survey of the area west (down-current) of the barge, only approximately 50 percent of suspected targets were found to actually contain submerged oil. The use of side scan sonar for submerged oil detection was eventually discontinued due to the relatively high rate of false-positives, the need to visually verify results using divers or ROV, and the significant lag time for data processing and interpretation.

3.4.4 Remotely Operated Vehicle Surveys

Beginning on December 6, 2005, use of a tethered ROV to perform submerged oil identification surveys was initiated, though other submerged oil detection and assessment methods continued to also be used for a period of time. The ROV contained a video camera allowing continuous imagery of the seafloor to be viewed in real-time and recorded. However, the particular ROV used for these surveys lacked precise positioning equipment, so its position relative to the support vessel could only be estimated. The ROV was the primary means of verifying suspected submerged oil patches identified using alternative methods (e.g., side scan sonar). It was also used to systematically survey the seafloor in areas not surveyed using side scan sonar. Approximately 85 ROV surveys were conducted, mostly west and west-northwest of the barge. ROV use was constrained by limited mobility, and at times, rough seas, poor visibility and oil fouling. ROV survey maps and reports are provided in Appendix E.

A standardized ROV survey protocol, described below, was developed to promote consistent results across multiple survey locations being evaluated by different teams. The procedure was designed to acquire data for quantitative estimation of oil volume within discrete patches of submerged oil. At each site, a 30-minute survey was conducted by piloting the ROV just above the seafloor along a varying directional track line approximating a closed polygon and covering as much area as possible. The dimensions and percent cover of oil observed along each segment of the track line were recorded. The ROV was diverted from its track to determine the dimensions of any large oil patches encountered along the track line. The volume of oil contained within each patch was then calculated using the length (based on travel time and speed) and width of the observation window along the track line and the percent cover of oil deposits greater than six inches in diameter observed on the seafloor. An allowance was also made for the contribution of background oil droplets less than six inches in size.

3.4.5 Seafloor Oil Migration Monitoring Plan

At the request of the FOSC, the Environmental Unit prepared a plan for monitoring the potential migration of oil along the seafloor in the vicinity of the barge site (Appendix F). The plan did not address oil located in Area B because, at the time these investigations were performed, the oil appeared to be contained within the scour trench.

Three methods were identified and tested to assess their ability to track the potential migration of submerged oil:

- Vertical Snare Samplers;
- Staking of oil patches; and
- Filter fences.

Vertical Snare Sampler (VSS) devices consisted of multiple snare pompoms positioned along a length of rope with an anchor on one end and a buoy float on the other to hold it in a near-vertical position in the water column. Later iterations also included snare-filled crab pots positioned to rest on the seafloor. These devices were deployed at specific locations for one or more days to detect submerged oil both on the seafloor and in the water column. Staking of oil patches consisted of physically marking the perimeter of three known patches of oil and assessing whether or not these patches moved over time relative to the stakes. The filter fence method consisted of assessing oil accumulation on water-permeable mesh fabric panels attached to fence posts driven into the seafloor. Three filter fences were deployed west (down-current) of the western edge of documented oil.

The seafloor oil migration plan was implemented in late-November 2005. Two of the three methods tested proved to be unsuccessful. Upon returning to the last known locations of the designated oil patches to stake their perimeters, the previously observed oil mats were no longer present. So, while it could be determined that the oil patches had moved, it was not possible to track their migration. Filter fences were unsuccessful because bottom currents and/or propagated wave energy tore the fabric from the posts, which prevented accumulation of oil on the mesh panels should it have been present.

In the end, staking and filter fabric methods were abandoned in favor of VSS devices and other methods of submerged oil tracking whose effectiveness had been previously demonstrated (e.g., V-SORS and ROV).

Once the capability of the VSS devices to successfully track submerged oil migration was determined, the Environmental Unit began deploying them to monitor the potential for short-term movement of submerged oil, an objective that could not be as easily accomplished using V-SORS. Unlike V-SORS, VSS devices provided a time-integrated assessment at a single location.

The VSS devices were checked with varying frequency and redeployed at either the same or new locations depending on the results. Monitoring intervals ranged from a few days to sometimes over a week depending on weather conditions and resource needs. Tracking submerged oil movement with VSS eventually evolved into long-term monitoring (see Section 4.0). The results of VSS monitoring efforts through early-January 2006 are provided in Appendix G.

3.4.6 Support of Submerged Oil Recovery Operations

As described in the USCG options analysis memo (Appendix H), a variety of options for recovering submerged oil were considered. Diver-directed pumping was selected as the preferred method. Full-scale recovery operations using this method were initiated on or about December 12, 2005 using the deck barge "Mr. Two Hooks". At this time, Environmental Unit activities shifted away from large-scale delineation and tracking of submerged oil and focused primarily on operational support of oil recovery efforts, though some of the former activities were continued.

Due to equipment scarcity in the Gulf Region following Hurricanes Katrina and Rita, a single submerged oil recovery platform—the deck barge "Mr. Two Hooks" outfitted with the necessary anchoring, pumping, and diver-support equipment—was the only cleanup asset used for this response. As a result, submerged oil cleanup proceeded slowly. The rate of submerged oil recovery was further restricted by the limited mobility of the barge. Daily cleanup was effectively confined to a maximum area of approximately 600 ft. x 800 ft. based on the ability to maneuver the barge using its four-point mooring system without resetting the anchors, which required considerable time and support assets. These factors necessitated the prioritization of cleanup in a manner that targeted discrete accumulations containing the highest concentration of submerged oil (e.g., greatest volume of oil per unit area). Therefore, identifying and prioritizing "targets" for submerged oil recovery became the Environmental Unit's primary mission. Accomplishing this objective required (1) locating discrete oil deposits, (2) quantifying the amount of oil present, and (3) defining "recoverable" oil. A conducive weather window was necessary for achieving these objectives.

V-SORS and VSS did not provide sufficient spatial resolution to identify discrete accumulations of submerged oil considered as potential candidates for recovery. Of the available methods, only visual surveys of the seafloor proved to be capable of delineating submerged oil deposits with the necessary level of detail and accuracy. As discussed in Section 3.4.4, most surveys of this nature were conducted using an ROV. Observational data from ROV surveys was used to estimate both patch size and percent cover of oil using standardized methods described previously. The third parameter needed to estimate the concentration of submerged oil within discrete patches—oil thickness—was determined primarily by divers.

The results of ROV target identification surveys to locate and estimate the volume of oil within candidate cleanup areas were compiled and updated periodically as new data became available. Survey results as of January 4, 2006 are included in Appendix E along with maps showing survey results. "Recoverable" oil was initially defined by the Unified Command as any discrete accumulation of submerged oil having an estimated volume of at least 100 barrels or 60 percent cover, where oil volume was calculated based on patch size, percent oil cover, and oil thickness[4]. These thresholds for initiating recovery were established based on observed trends in the survey results that appeared to separate smaller, more scattered oil deposits from larger, higher volume accumulations of submerged oil, where in the Unified Command's view, the potential benefits from submerged oil recovery were justified given the logistical complexities, time requirements, and safety considerations associated with recovery operations.

The definition of recoverable oil was later amended such that submerged oil recovery would be initiated at locations containing a minimum of 500 barrels of oil. This ensured that the Mr. Two Hooks was only deployed at locations where there was a minimum of 500 barrels to recover. A background level of oil fragments less than six inches was also calculated and the coverage extrapolated to the full Mr. Two Hooks area. This allowed a small additional amount to initiate recovery operations when the volume of oil mats and larger globules was not quite 500 barrels.

[4] For purposes of estimating oil volume, an average thickness of 1.5 inches was applied based on diver and ROV measurements, which ranged from 1-2 inches.

3.5 ENDPOINT CONFIRMATION

Submerged oil assessment and delineation efforts conducted through early December 2005 suggested that the majority of potentially recoverable oil was located immediately down-current (west and west-northwest) of the capsized barge (Area A) within the swing radius of the anchored vessel. As part of an effort to narrow the geographic focus of on-going submerged oil assessment activities consistent with its operational support role, the Environmental Unit undertook steps to develop and assess cleanup endpoints related to submerged oil recovery. This process was analogous to the shoreline inspection and sign-off process typically used during shoreline cleanup for spills of floating oil. However, in this case, the inability to visually inspect potentially impacted areas in their entirety required the use of alternate approaches based on indirect observation and statistical sampling.

In early December 2005, the Environmental Unit drafted the Endpoint Confirmation Plan, which proposed a cleanup endpoint criterion of “very light” oiling or less determined using V-SORS, and outlined plans for surveying a 261 square mile area potentially containing submerged oil (Appendix I). The primary objective of surveys conducted pursuant to this plan was to document the absence of submerged oil in recoverable quantities throughout portions of the survey area geographically removed from the barge site, and in doing so provide justification for focusing future investigation and recovery efforts in those areas most likely to contain recoverable oil within the swing radius of the barge and immediately down-current.

Endpoint confirmation surveys were performed December 11-16, 2005 as weather permitted. The results of the surveys confirmed oiling levels of very light or less within approximately 90 percent (234 square miles) of the 261 square mile search area. Higher oiling levels that did not meet the endpoint criterion were identified within an area of approximately 27 square miles west of the barge (Area A), including an approximately 3 square mile area immediately down-current of the capsized barge containing the highest known oiling levels.

Based on the results of the endpoint confirmation surveys, it was recommended that areas meeting the endpoint criterion be removed from active cleanup consideration and addressed through the NRDA process. In mid-December, the USCG initiated the orderly transition from emergency response phase conducted under the authority of the FOSC to the damage assessment and restoration phase under the purview of the natural resource trustees of all but the approximately 3 square mile area within the swing radius and immediately down-current of the capsized barge containing the highest known oiling levels. From this point forward, recovery operations focused on submerged oil survey and recovery operations located within the swing radius of the barge and the area immediate down-current.

3.6 TRANSITION TO LONG-TERM MONITORING AND DEACTIVATION OF INCIDENT COMMAND POST

Though slow and laborious, diver-directed pumping proved capable of recovering some oil from the seafloor. However, submerged oil recovery efforts were severely hampered by weather constraints, limiting large scale recovery. Seasonal weather patterns in the northern Gulf of Mexico are characterized by increased frequency of cold fronts between October and April, with frontal passage marked by dramatic changes in wind direction and significant increases in wind speed and wave height (Kobashi et al., 2005).

Favorable weather “windows” during which conditions were calm enough for recovery operations to occur were typically on the order of 3-4 days followed by often as many days of high winds and heavy seas during and immediately following frontal passage leading to roughly 50 percent weather-related downtime. For safety reasons, the Mr. Two Hooks submerged oil recovery barge and dive teams were unable to remain on-station during these weather events, and instead were forced to return to port, which entailed a 12-18 hour transit each way. Heavy weather also mobilized submerged oil deposits, making it necessary to relocate cleanup targets prior to resuming recovery operations. To further confound matters, poor bottom visibility after storms often delayed the process of relocating submerged oil deposits using divers or ROVs. It was not uncommon to spend a significant portion of the available weather window relocating oil and repositioning the recovery barge.

At the request of the FOSC, the Environmental Unit prepared a memorandum in early January 2006 outlining, among other things, the rationale for transitioning from initial response/submerged oil recovery to long-term monitoring (Appendix J). The following points were put forth justifying suspension of submerged oil recovery operations:

Oil recovery operations had become increasingly inefficient due to substantial weather delays that provided only narrow weather windows (1-3 days out of 7 at best). The location of oil had to be reconfirmed prior to each deployment of the recovery platform due to oil movement during heavy weather. Additionally, at least one day of calmer weather was necessary for visibility to improve prior to resuming ROV/confirmation surveys, thus consuming a portion of the weather window.

Larger discrete accumulations of submerged oil were predicted to continue to break-up and be redistributed into more widely scattered fields of smaller oil globules during heavy weather events.

The submerged oil did not appear to pose an immediate threat to human health based on available information.

Potential impacts to the water column and associated natural resources from the oil were very low based on comparison of sampling results to applicable water quality criteria for the protection of aquatic life. Nine (9) of 49 samples exceeded NOAA's acute ambient water quality screening value in marine waters for total polycyclic aromatic hydrocarbons (PAH) (300 parts per billion).

Despite diligent efforts to recover submerged oil, only an estimated 2,355.26 barrels were recovered by divers as of January 11, 2006.

The proposed long-term monitoring program (see Section 4.0) would provide for early warning of potential impacts to sensitive environmental resources and commercial fishing interests. In the event of impacts to fishing or other commercial interest, a claims process was in place to ensure affected parties would be properly compensated.

Continued recovery of oil was not expected to have had significant environment benefit and was not expected to substantially mitigate the potential for future impacts to natural resources at risk. The natural resource damage assessment process would address potential impacts to natural resources at risk from non-recovered oil and would provide appropriate restoration if deemed necessary by the trustees.

Based on these considerations, the Environmental Unit proposed that active submerged oil recovery operations be suspended as of the next weather-related demobilization of the recovery platform Mr. Two Hooks and its attendant assets. At such time, long-term monitoring would be initiated and performed over the winter months as weather permitted. Once weather conditions improved the following spring, the need to resume submerged oil recovery operations would be evaluated by the Unified Command based on the long-term monitoring results.

The Environmental Unit's recommendation to fully transition from active cleanup to long-term monitoring was accepted by the Unified Command. Submerged oil recovery operations were suspended indefinitely beginning on the evening of January 12, 2006 pending reevaluation of the need to resume active cleanup upon return of more favorable weather conditions. The Incident Command Post in Port Arthur, Texas was deactivated the following day.

Immediately prior to demobilizing, the RP agreed to complete a final round of ROV surveys at 12 remaining sites west-northwest of the former barge location. Locations found to contain recoverable oil would be considered candidates for long-term monitoring to assess oil dissipation; however, no additional recovery would be performed. Six of the locations were surveyed in early February and no recoverable oil was located. USCG approved the Environmental Unit's request to abandon the remaining six surveys after several unsuccessful

SECTION 4

Long-Term Monitoring

4.1 OVERVIEW

At the time submerged oil cleanup operations were suspended in mid-January 2006, only a small fraction (later estimated at about 5 percent) of the total volume of spilled oil had been recovered. An estimated 43,491 barrels (1,826,622 gallons) of submerged oil remained either on the seafloor or dispersed or dissolved in the water column (see Section 6.0 for information on the oil budget/mass balance). At that time, it was uncertain whether submerged oil recovery operations would be restarted in the spring when more favorable weather returned.

To help assess the need for and feasibility of resuming oil recovery operations in the spring of 2006, in addition to other objectives listed below, the FOSC required the RP to perform LTM. LTM was initiated in January 2006 following termination of submerged oil recovery operations and continued for a period of approximately one year, through February 28, 2007.

The LTM program followed an adaptive management strategy. Throughout its course, the specific focus and approaches employed were modified to meet changing needs and conditions and also to apply experience gained from previous efforts. Before concluding, the LTM program evolved through three distinct phases. The first phase focused on assessing whether or not to resume submerged oil recovery operations once weather conditions improved in the spring of 2006. The second phase focused on confirming that the findings of the initial phase applied spatially throughout the entire submerged oil field. The third phase focused on investigating in greater detail a higher concentration area of submerged oil discovered during the second phase. A total of five different plans were developed to guide the evolving LTM process:

- Initial LTM Plan (Phase I);
- Revised LTM Plan (Phase I);
- Towed Video Plan (Phase II);
- Submerged Oil Verification/Calibration Plan (Phase III); and
- Bolus LTM Plan (Phase III).

Key components of these plans and significant results of LTM surveys in each phase are summarized in the sections below.

4.2 LONG-TERM MONITORING: PHASE I

Phase I LTM was conducted between January and June 2006.

4.2.1 Initial Long Term Monitoring Plan

Once it became apparent that submerged oil recovery operations would be suspended, at least temporarily, the FOSC required the RP to develop and implement a LTM plan to assess oiling conditions in the submerged oil field, the term given to the area containing scattered deposits of oil on the seafloor. The initial LTM Plan

(Appendix K) was prepared by the Environmental Unit and approved by the Unified Command in late-December 2005. However, due to weather delays, the plan was not implemented until several weeks later. The initial LTM plan was designed to:

- Track the movement and fate of non-recovered submerged oil to assess/document its extent and continued dispersion;
- Provide advance warning of potential impacts to Gulf Coast shorelines and other sensitive areas such as the Flower Garden Banks National Marine Sanctuary; and
- Document changes in the oil's chemical composition (e.g., fingerprint) and physical properties through time due to weathering.

Given the size of the submerged oil field and narrow weather windows, it was considered impractical to monitor the entire area containing oil, especially since it was expected to continue expanding as the oil migrated and dissipated. Therefore, initial LTM efforts focused on tracking the leading edges and perimeter of the submerged oil field, but not the interior. This was accomplished using stationary samplers similar to the VSS described in Section 3.4.5. Each device consisted of two stacked crab pots set on the seafloor, with the bottom pot weighted to maintain an upright position. Each pot was loosely filled with white snare. The crab pots were attached to a line anchored to the seafloor and the anchor was attached to a float on the surface by a second line. A snare-filled cylinder (1 m high x 0.25 m in diameter) constructed of wire mesh was attached to the second line and positioned at half the water depth to monitor for oil suspended in the water column. The bottom end of the cylinder was weighted slightly to ensure the device remained vertical.

A total of 34 stationary samplers arranged in four arrays (north, south, east, and west of the capsize location) were first deployed in mid-January 2006. Each array included an inner and outer row or ring of samplers. LTM cruises were conducted at 2-4 week intervals to inspect and re-deploy the LTM samplers according to procedures specified in the plan. Oiling classification methods were consistent with those used during the initial response phase. Results were photo-documented and representative samples of oiled snare were collected for potential laboratory analysis to assess chemical weathering. Sections 4.2.3 and 4.2.4 summarize results from the initial Phase I LTM efforts.

Since the location and dimensions of the submerged oil field were dynamic, sampling arrays were reconfigured by the survey teams in real-time based on their findings. If the inner ring samplers (e.g., those closest to the leading edge of the submerged oil field) were oiled, the oiled snare was replaced and the samplers were repositioned farther out beyond the outer row. This leap-frog approach was used to continually bracket the leading edge of the submerged oil field as it migrated to the west-northwest.

4.2.2 Revised Long-Term Monitoring Plan

In mid-March 2006, revised procedures for LTM were instituted to address the loss of stationary samplers and data due to theft and weather experienced during the first two LTM events. The original LTM plan was modified to use V-SORS Light chain drags instead of stationary samplers. However, the basic search pattern and procedures for changing the monitoring locations remained the same. In addition, the scope of LTM surveys was expanded to include monitoring of four locations within the interior of the submerged oil field containing known higher concentrations of pooled or matted oil. These oil deposits were first identified as cleanup targets during ROV surveys performed in the response phase, but were not cleaned before recovery operations were halted. The revised LTM plan is provided in Appendix L.

4.2.3 Long Term Monitoring Results January through March 2006

In anticipation of seasonal improvements in offshore weather, the Unified Command and representatives of the Environmental Unit met in April 2006 to discuss the need to resume submerged oil recovery. Results of the first four LTM cruises conducted between January and March 2006 were presented and the following major findings were discussed:

- Continued redistribution and dissipation of submerged oil accumulations was evident;
- The rate at which submerged oil was migrating to the west-northwest was slow;
- Submerged oil did not pose an imminent threats to shorelines; and
- Continued cleanup, even if feasible, would do very little to mitigate future adverse impacts resulting from the continued presence of submerged oil.

Based in large part on this information, the Unified Command concluded that resumption of submerged oil recovery operations was not justified at that time. However, the parties agreed that continued monitoring of the submerged oil field would be prudent. Moreover, the Unified Command expressed concern over the current LTM approach's focus on surveying primarily the perimeter of the submerged oil field. The Unified Command advised the RP that a more comprehensive survey would be required to confirm that findings from perimeter areas applied throughout the entire submerged oil field before LTM efforts could be terminated. Anticipating such a requirement, the RP shared their initial thoughts and ideas about the possible use of towed video to survey interior portions of the submerged oil field. It was agreed that LTM would continue under the current approach until a plan for a comprehensive survey, likely using towed video, was approved. Maps depicting the results of the initial LTM surveys are provided in Appendix M.

4.2.4 Long Term-Monitoring Results April through June 2006

Three additional LTM events were conducted prior to refocusing LTM efforts towards a comprehensive survey of the submerged oil field using towed video. Overall, the results of these surveys were consistent with previous findings that indicated the submerged oil field was generally migrating to the west-northwest and oiling levels at the leading edges were decreasing through time. These results were interpreted as an indication that larger, discrete accumulations of submerged oil were continuing to break up and dissipate through time, which was consistent with NOAA predictions as well as observations from the oil mat monitoring locations.

The farthest occurrence of heavy oil during the first six months of LTM was observed approximately 7 nm west-northwest of the capsize location in late-March 2006. In mid-June 2006, moderate oil was observed approximately 8 nm west-northwest of the capsize location and was the heaviest oil observed at the time. Light and very light oil was observed in June 2006 up to approximately 13 nm west-northwest of the capsize location. This was the farthest distance from the capsize location at which oil was observed throughout the entire LTM program. Maps depicting the results of each survey are presented in Appendix M.

4.3 LONG-TERM MONITORING: PHASE II

Phase II LTM consisted of a single towed-video survey which was conducted July 18-20, 2006.

4.3.1 Towed Video Survey Plan

As previously noted, the Unified Command required the RP to perform a comprehensive survey of the entire submerged oil field to confirm the dissipation of heavier submerged oil deposits and demonstrate the absence of recoverable[5] oil as a condition for terminating LTM.

A plan was developed to survey the submerged oil field using a sled-mounted video camera towed across the seafloor along parallel transects extending throughout the known extent of significant oiling (Appendix N). This approach was intended to provide direct visualization of residual submerged oil, as well as digital imagery that could be used to quantify spatial parameters of submerged oil such as patch size, distribution and percent cover. Chain-weighted sorbents would be mounted on the rear of the camera sled to provide a secondary method for assessing submerged oil and also a basis for “calibrating” previous sorbent drag results based on direct comparison of oil on the seafloor and oil retained on sorbents.

The towed video survey was intended to be the final assessment necessary before all response activities could be terminated. If the results of previous LTM surveys were confirmed and no recoverable oil was encountered, all parties were in agreement that response could be terminated, including the potential resumption of submerged oil recovery operations. This would mean that the matter could then be fully transitioned to the natural resource damage assessment process.

The towed video survey was performed July 18-20, 2006. Bottom visibility and equipment malfunctions precluded the full visual evaluation that was originally intended. However, the sorbent drags provided important data about oiling conditions within the interior of the submerged oil field. The results of this survey are presented in Table 4-1 and depicted in Figure 4-1.

Twelve (12) transects totaling 47.5 nm were surveyed. Overall, the survey results continued to suggest dissipation of heavier concentrations of oil at most locations within the submerged oil field. Very light oiling was most prevalent, accounting for 62 percent of the distance surveyed, while approximately 30 percent of the total surveyed length contained no oil. However, small patches of heavy and moderate oiling constituting 0.7 and 1.7 percent of the surveyed area by length, respectively, were identified approximately seven (7) nm west-northwest of the capsize location in line with the general direction of observed oil movement. The extent of the heavy oiling beyond the towed video transect was not fully delineated during the July survey.

Table 4-1 July 2006 Oiling Observations within the Submerged Oil Field

Oiling Category	Length of Oiling (nm)	Percent Total (%)
No Oil	14.0	29.5
Very Light	29.4	62
Light	2.9	6.1
Moderate	0.8	1.7
Heavy	0.3	0.7

[5] “Recoverable” oil for this incident was defined as concentrations of submerged oil sufficient for an estimated recovery rate of 500 barrels or more per diver recovery team per day, as established by the Unified Command before the suspension of cleanup operations in January 2006.

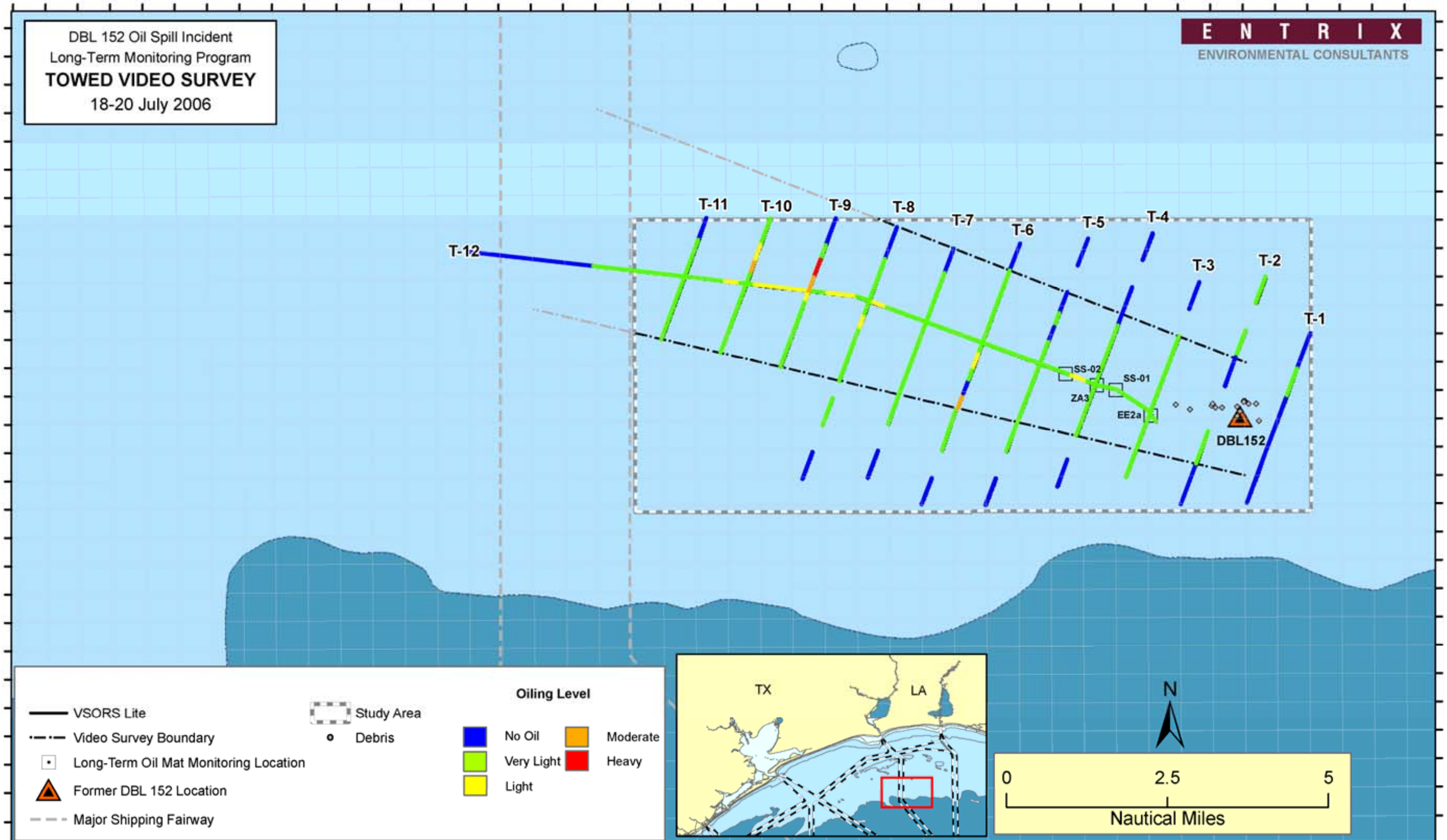

Figure 4-1 July 2006 Oiling Observations within the Submerged Oil Field.

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4.4 LONG-TERM MONITORING: PHASE III

Phase III LTM was conducted between September 2006 and January 2007.

4.4.1 Submerged Oil Verification/Calibration Survey Plan

The identification of heavy oil during the towed video survey (see Table 4.1) raised questions about the continued existence of submerged oil deposits in recoverable quantities and concentrations. To help answer this question, the Submerged Oil Verification/Calibration Survey Plan was developed in early September 2006 at the direction of the Unified Command (Appendix O). The primary objective of this plan was to determine if the heavy oil identified during the towed video survey represented recoverable oil. The plan was also designed to calibrate heavy oil determinations made with V-SORS Light, since this objective had not been accomplished during the towed video survey. The V-SORS calibration was to be based on visual characterization of submerged oil by divers as the primary means of data collection and drop camera imagery as a secondary method of documentation. The plan was also developed to investigate whether submerged vegetation/algal mats observed during the towed video survey were a biological indicator of recoverable oil. In order to accomplish these objectives, the plan included a three-stage process that entailed (1) relocating and establishing 2-4 target areas from the heavy oil identified during the July 2006 towed video survey using V-SORS Light; (2) surveying the heavy oil targets using divers; and (3) resurveying the same heavy oil targets using a drop camera.

The plan was implemented in mid-September 2006. After relocating heavy oil identified along Transect T-9 during the July 18-20, 2006 towed video survey, four new transects were surveyed using V-SORS, divers and a drop camera. These newly surveyed transects included two (2) transects designated as very heavy (snare saturated with oil), one (1) as heavy, and one (1) as moderate using V-SORS Light chain drags. Divers estimated percent cover of oil for the two (2) very heavy transects at 50-60 percent each. Pools of oil were observed ranging from 6-14 feet in diameter, with some larger areas estimated to be 20-30 feet in diameter. Oil thickness was 1 to 1.5 inches typically, with a few areas reported to contain oil up to 2 inches thick. No significant amounts of oil were observed during either diver or drop camera surveys in the vicinity of the heavy or moderate transects. Average cover by oil for the two very heavy transects determined from drop camera imagery ranged from 23 to 44 percent, which was lower than the visual estimates provided by divers. The survey team was unable to fully delineate the extent of the heavy oil patch. However, results confirmed that submerged vegetation/algal mats were not utilizing oil as an attachment substrate and therefore did not represent a biological indicator of recoverable oil.

A follow-up survey was conducted two weeks later in late-September 2006 to complete the delineation of the heavy oil patch using V-SORS Light and the drop camera. This survey delineated a patch of heavy and very heavy oil within an area measuring approximately 305 m x 305 m (about 1,000 by 1,000 feet), located approximately 450 m to the west-northwest of the heavy oil identified during the towed video survey in July. This patch was determined to be the same heavy oil observed during the July survey (in a new location) and became known as the “bolus”. Portions of the bolus were surveyed using a drop camera. Percent cover of submerged oil was quantified using underwater video imagery from nine (9) drift transects located throughout the bolus. Estimates of percent cover calculated from the underwater video data were highly variable ranging from zero to 100 percent cover at individual drop locations. The average percent cover of oiled seafloor within the bolus ranged from 5.5 to 6.5 percent depending on cover determination method (ocular estimation vs. point count) and sample size (n=71 vs. n=268). Average percent cover for individual transects ranged from zero (0) to 21.9 percent. Based on these cover values, the cumulative area of seafloor covered by oil within the bolus ranged from 1.02 to 1.21 acres. Using an average oil thickness of 1.25 inches (calculated above), the bolus was estimated to contain between 827 barrels and 977 barrels of submerged oil, or approximately 2 percent of the total volume of submerged oil that remained unrecovered at the time recovery operations were suspended in January 2006. Additional details about the methods used to quantify oil from the underwater video images are described in Appendix P.

On October 30, 2006 members of the Unified Command reconvened to discuss the need for additional submerged oil recovery, additional LTM and the discovery of the bolus. Potential short- and long-term risks to various resources at risk were discussed, as well as options (remedies) to mitigate these potential risks. There was general agreement by all parties that:

- The amount of oil contained within the bolus and its persistence as a high-concentration feature remained uncertain;;
- Both short- and long-term threats to benthic habitat were low;
- Both short- and long-term risk to benthic biota and sea turtles was low;
- The short-term risk to fisheries was low;
- The observed migration rate to the west-northwest remained slow; and
- The short-term threat of shoreline impacts was minimal.

TGLO did not share the view that the long-term potential for shoreline impacts was minimal; however, they agreed to defer to the USCG and NOAA until such time as oil from the incident enters state waters. Despite this difference of opinion, the Unified Command agreed that there was little justification for further attempts to recover oil from the bolus and decided that continued monitoring was the most prudent course of action.

4.4.2 Bolus Long Term Monitoring Plan

The Bolus LTM Plan was developed to track the movement and spatial characteristics of the bolus using V-SORS-Light, divers and drop camera imagery, and to perform ongoing chemical monitoring using oiled snare samples. The plan also included provisions for considering resumption of submerged oil recovery if conditions warranted. The plan was finalized and approved in early December 2006. A total of three monitoring surveys were performed under the Bolus LTM Plan. The plan and survey results are provided in Appendix Q.

During the first two surveys, which occurred in early and mid-December, no heavy oil was observed during V-SORS Light chain drags at the former and expected location of the bolus. Only a small area of moderate oil surrounded by areas of light and very light oil was delineated slightly west of the September 2006 location of the bolus. Based on its location and the results of fingerprinting analysis, it was determined that this oil was in fact the remains of the bolus, but had dissipated significantly since the previous survey in late-September. Poor bottom visibility prevented visual observations of residual oil on the seafloor with the drop camera.

The third and final bolus LTM survey was performed in mid-January 2007. This survey indicated only light and very light oil in approximately the same location where the remnants of the bolus had been observed the previous month. In addition, areas that contained heavy and very heavy oil in September 2006 contained only very light oil in January 2007. The search area for the final bolus LTM survey was large enough to provide a high degree of confidence that the bolus had not gone undetected. Additionally, forensic analysis of weathered oil samples confirmed the similarity of oil collected from the bolus in September 2006 and light and very light oil collected from the dispersing remnants of the bolus in December 2006 and January 2007. Poor visibility again thwarted attempts to visually assess submerged oil on the seafloor with the drop camera. No additional LTM surveys were performed after mid-January 2007.

4.5 FINAL TRANSITION TO DAMAGE ASSESSMENT

Members of the Unified Command and Environmental Unit met in Port Arthur, Texas on February 8, 2007 to discuss LTM activities and other action items. The RP recommended termination of all LTM efforts based on the results of the three previous surveys. This recommendation was agreed to by the USCG, NOAA and TGLO. The need to formally close out the response phase and fully transition the case into the NRDA process under the Oil Pollution Act of 1990 was also discussed during this meeting. It was decided that ENTRIX would summarize Environmental Unit activities on behalf of the USCG and provide the report to USCG, NOAA, and TGLO.

On February 28, 2007, the USCG authorized the transition from the emergency response phase to the injury assessment and restoration phases under the authority of NOAA, the sole natural resource trustee as of this time (Appendix R).

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SECTION 5

Shoreline Contingency Planning

Early in the response, concerns were expressed, primarily by the State of Texas, about the potential for shoreline impacts resulting from this incident. Both NOAA and the RP believed the potential for coastal impacts from submerged oil was low, but acknowledged that the unknown, but relatively small quantity of floating oil initially released could potentially impact shorelines in the form of tarballs and/or tar patties. To address concerns over potential shoreline impacts, the RP undertook some basic shoreline assessment and cleanup contingency planning steps.

On December 7, 2005, members of the Environmental Unit and the RP’s spill management team met with state and federal representatives from the South Texas Coastal Zone in Corpus Christi, Texas. The meeting was intended to familiarize the RP with the local entities, environment and issues relevant to shoreline cleanup and to provide a forum to discuss the agencies’ concerns and expectations regarding quick, effective and efficient shoreline response should the need arise. The presentation given by TGLO at this meeting is provided in Appendix S.

5.1 RECONNAISSANCE-LEVEL SHORELINE ASSESSMENT PLAN

During the course of their normal duties, TGLO Oil Spill Prevention & Response (OSPR) Regional Field Office personnel regularly monitor the shorelines for tarballs, which can be a common occurrence along the Texas Gulf Coast. Following the incident, these efforts received increased attention given the state’s concern for potential shoreline impacts.

In response to these concerns, the Reconnaissance-Level Shoreline Assessment Plan (Appendix T) was developed by the Environmental Unit to provide a framework for the shoreline monitoring activities already being performed by TGLO and, most importantly, to establish procedures for documenting and communicating the results of these efforts back to the Environmental Unit and Unified Command in a standardized, organized manner. The primary means of shoreline assessment under this plan was periodic "spot-checks" conducted by TGLO OSPR personnel from each of the five (5) regions along the Texas Gulf Coast. Initial surveys by the TGLO were completed by November 21, 2005. Subsequent surveys were performed weekly targeting new shoreline areas each time. Survey documentation was forwarded to the Environmental Unit weekly and the results were compiled and mapped (see Appendix U). The plan also contained provisions for ad-hoc observations by government and private sector stakeholders whose normal operations provided opportunities for incidental observation of potentially impacted shorelines. These entities were contacted by TGLO shortly after the incident and instructed to notify the local TGLO or USCG representative if they observed oil.

According to the plan, if TGLO or USCG personnel encountered oil, cleanup would be initiated immediately per the agency’s standard procedures. TGLO would also send an oil sample for fingerprinting analysis, notify the Environmental Unit Leader, and provide the RP with a split sample of the oil. If the oil was determined to be from the T/B DBL 152, the responding agency would seek cost recovery from the RP, or the RP could elect to assume management of the cleanup if it were not yet completed.

Weekly spot checks and submission of shoreline assessment documentation were performed through December 19, 2005 after which time they were discontinued. No shoreline oiling suspected to be from the T/B DBL 152 incident was identified by TGLO or other stakeholders during this period.

5.2 PRELIMINARY SHORELINE CLEANUP PLAN

At the request of the Unified Command, the Environmental Unit also prepared a Preliminary Shoreline Cleanup Plan (Appendix V). The objective of this plan was to identify preferred shoreline clean-up methods in the event shoreline habitats were impacted by oil. If this were to occur, clean-up operations would be initiated under the direction of the Unified Command. Manual removal of tarballs and/or tar patties, the expected form of any oil from the T/B DBL 152 that could potentially impact shorelines, was identified as the preferred cleanup method. All shoreline clean-up operations would be coordinated with TLGO and would comply with TGLO guidance as described in the document entitled *TGLO OSPR Programmatic Guidance for possible Gulf facing beach impacts as a result of DBL 152* (Appendix X) as well as the Area Contingency Plan.. The plan also included provisions for subdividing the shoreline into smaller segments based on habitat type, oiling level, and other operational considerations.

5.3 TARBALL INCIDENTS

Following the closure of the command post in mid-January 2006, the RP was notified by the TGLO and USCG about tarball discoveries on Texas shorelines on four occasions:

- South Padre Island –March 9, 2006
- Mustang Island – March 29, 2006
- Boca Chica Beach – May 3, 2006
- High Island – May 19, 2007

In each instance, oil samples were collected by TGLO and sent to the USCG Marine Safety Laboratory in Groton, Connecticut for fingerprinting analysis. None of the stranded shoreline oil was found to originate from the T/B DBL 152. Information and analytical results, which are provided in Appendix W, were disseminated to members of the Unified Command each time.

SECTION 6

Oil Budget / Mass Balance

An oil budget/mass balance was prepared by ENTRIX on behalf of the RP and submitted to the USCG in June 2007 (Appendix X). The report presented estimates for the amounts of oil released into the Gulf of Mexico, recovered during submerged oil cleanup operations, and left remaining in the environment. These estimates were based on the volume of oil onboard the barge at the time of the incident and the volumes of oil recovered during lightering, final cleaning, and diver-directed submerged oil cleanup. Source information consisted of tank gauging reports, waste manifests, invoices, analytical reports and personal accounts. Key information from the oil budget/mass balance report is summarized below.

The vessel ullage report stated that the T/B DBL 152 was carrying 120,033.32 barrels of slurry oil when it departed Houston Fuel Oil Terminal. The oil had a water content of 0.2 percent as determined by distillation. Therefore, the net volume of oil onboard the barge at the time of the incident was 119,793.25 barrels.

A total of 126,770.51 barrels of oil and water were removed from the barge during offshore lightering operations, of which 58,840.92 barrels were oil. Once adjusted for the 30 percent water content of the oil fraction, the net volume of oil recovered during lightering was 40,607.88 barrels. Using information from waste manifests and disposal invoices, it was determined that the gross volume of oil removed from the barge in Theodore, Alabama, the location where final cleaning took place, was 55,565 barrels. Analysis performed by the contractor indicated the water content of the oil ranged from 30 to 50 percent. Using the midpoint of the water content range (40 percent), the net volume of oil recovered in Theodore was determined to be 33,339 barrels. In total, approximately 62 percent of the cargo was removed from the barge without oil entering the environment.

Based on the total volume of oil onboard the T/B DBL 152 at the time of the incident, and the estimated amounts of oil removed during lightering and final cleaning, the estimated volume of oil released into the environment from this incident is 45,846.37 barrels or approximately 38 percent of the total cargo. Of this amount, it is estimated that divers removed at least 2,355.26 barrels from the seafloor during submerged oil recovery operations, or approximately 5 percent of the total volume released. Therefore, it is estimated that 43,491.11 barrels of oil remained in the environment at the time submerged oil recovery operations were terminated in mid-January 2006.

The oil budget/mass balance did not attempt to quantify the amounts of oil recovered by V-SORS or other sorbents used for submerged oil detection and monitoring, or other oily solid waste generated during the response. Nor were the relatively small volumes of oil that leaked from the barge or were recovered during subsequent cleanup operations at Theodore Industrial Port included. All of these volumes were determined to be negligible in comparison to the amounts of oil reported above. Loss of submerged oil volume due to dissolution in the water column was not quantified.

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SECTION 7

References

Kobashi, D., F. Jose and G. Stone. 2005. Hydrodynamics and Sedimentary Responses within the Bottom Boundary Layer: Sabine Bank, Western Louisiana.: *Gulf Coast Association of Geological Societies Transactions*, v. 55, p. 392-399.

National Research Council. 1999. Spills of Nonfloating Oils: Risk and Response. *National Academy Press*, Washington, DC, 75 pp.

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APPENDIX A

Laboratory Report for DBL-152 Oil Samples

APPENDIX B

Spill Trajectories

APPENDIX C

Transport of Submerged Oil

APPENDIX D

V-SORS Survey Maps

APPENDIX E

ROV Surveys and Reports

APPENDIX F

Seafloor Oil Migration Monitoring Plan

APPENDIX G

VSS Survey Results

APPENDIX H

USCG Submerged Oil Recovery Options Memo

APPENDIX I

Endpoint Confirmation Plan

APPENDIX J

Transition from Emergency Response to LTM

APPENDIX K

Initial LTM Plan

APPENDIX L

Revised LTM Plan

APPENDIX M

LTM Results

APPENDIX N

Plan for Surveying Submerged Oil Field

APPENDIX O

Submerged Oil Verification/Calibration Plan

APPENDIX P

Quantification of Submerged Oil

APPENDIX Q

Bolus LTM Plan and Results

APPENDIX R

Transition to NRDA

APPENDIX S

TGLO Shoreline Presentation

APPENDIX T

Reconnaissance-level Shoreline Assessment Plan

APPENDIX U

Shoreline Survey Results

APPENDIX V

Shoreline Cleanup Plan

APPENDIX W

Tarball Fingerprinting Analytical Results

APPENDIX X

Mass Balance Report